(viii) If the axial force in the member is 100 kN then the lacing shall be proportioned to resist a total transverse shear of
(a) 2.5 kN (b) 3.5 kN (c) 1.5 kN (d) 4.5 kN.

(ix) What is the maximum slenderness ratio of lacing bars?
(a) 135 (b) 145 (c) 155 (d) 165.

(x) Which of the following formula is used to calculate the design bending strength of a laterally unsupported beam?
(a) $\beta_b Z_p f_y/\gamma_{m0}$ (b) $\beta_b Z_p f_{bd}/\gamma_{m1}$
(c) $\beta_b Z_p f_{bd}/\gamma_{m0}$ (d) $Z_p f_{bd}/\gamma_{m0}$

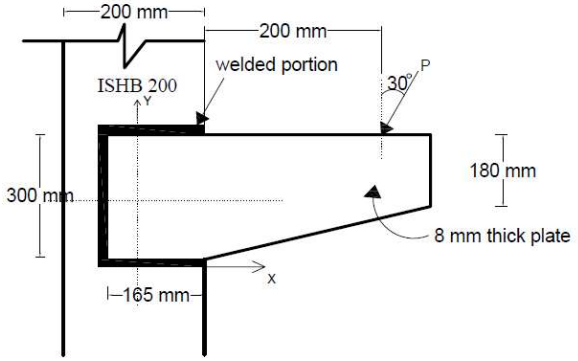
Group – B

2. (a) Calculate the shear capacity of a M20 bolt of grade 4.6 under double shear. Diameter of the bolt hole = 22 mm, pitch of the thread = 2.5 mm and assume only one shear plane is in thread area.

(b) Explain different types of bolted connection with neat sketch.

8 + 4 = 12

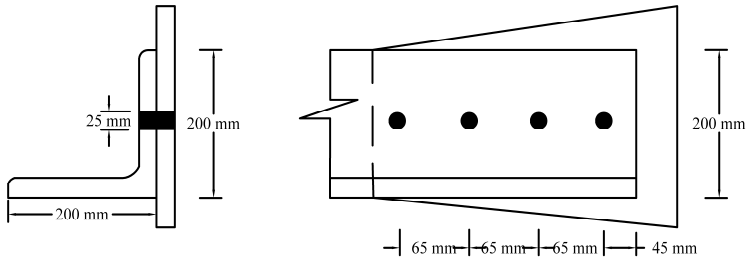
3. Determine the maximum load (P) that could be resisted by the bracket connection shown in the following figure. Neglect the plate thickness and 6 mm fillet weld is used in both directions.



12

Group – C

4. (a) Find out the tensile strength of an ISA 200×200×12 considering "Gross Section Yielding", "Net Section Rupture" and "Block Shear Failure" for the arrangement of bolts shown in the following figure. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2. Gross area of the angle is 46.61 cm^2.



(b) Find out the compressive strength of a 3.0 m long ISA 200 × 200 × 12 assuming that it is connected through one leg only, when
i. it is connected by two bolts at each end and hinged condition.
ii. it is connected by two bolts at each end and fixed condition.
iii. it is connected by one bolt at each end.
Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2, E = 2 × 10^5 N/mm^2. Gross area (A_g) of the angle is 46.61 cm^2 and radius of gyration about the minor axis (r_{vv}) is 1.36 cm.

6 + 6 = 12

5. A 6 m long column, fixed at base and hinged at top, is subjected to 920 kN axial compressive load at top, 230 kN-m moment at the base and 3 kN lateral shear acting at the base of column. All the given loads and moments contain their factored values. The column is fabricated using 2-ISMB 350 @ 52.4 kg/m spaced 500 mm apart from each other measuring from their centroids. Check whether the built–up section is satisfactory to carry the applied loads. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2, E = 2 × 10^5 N/mm^2, sectional area (A) of each I – section = 66.71 cm^2, I_{xx} = 13630.3 cm^4, I_{yy} = 537.7 cm^4, width of flange (b_f) = 140 mm, thickness of flange (t_f) = 14.2 mm, thickness of web (t_w) = 8.1 mm.

12

Group – D

6. Check the safety of an ISMB 200 @ 25.4 kg/m laterally unrestrained subjected to factored bending moment 25kN-m and factored shear force 50 kN. The length of the simply supported beam is 1.5 m. Check for deflection also. Consider E250 (Fe410 W)A. The properties of ISMB 200 @ 25.4 kg/m are given as follows: sectional area (a) = 32.33 cm^2, depth of section (h) = 200 mm, width of flange (b) = 100 mm, thickness of flange (t_f) = 10.8 mm, thickness of web (t_w) = 5.7 mm, Radii of Gyration (r_z) = 10.8 cm, r_y = 2.15 cm, section modulus (Z_{ez}) = 223.5 cm^3, plastic modulus (Z_{pz}) = 253.86cm^3.

12

7. A laterally supported beam of simply supported span 6.5 m is subjected to 40 kN/m uniformly distributed load for the entire span. The load value is un-factored and the dead load is included in it. The width of supports are 150 mm at each end and the depth of the beam is limited to 400 mm. The beam is fabricated using ISMB 350 @ 52.4 kg/m with 16 mm thick flange plates attached at the top and bottom of the beam. Check the adequacy of the section and suggest necessary curtailment of the flange plates. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2, E = 2 × 10^5 N/mm^2, sectional area (A) of I – section = 66.71 cm^2, I_{xx} = 13630.3 cm^4, I_{yy} = 537.7 cm^4, width of flange (b_f) = 140 mm, thickness of flange (t_f) = 14.2 mm, thickness of web (t_w) = 8.1 mm.

12

Group – E

8. A welded gantry girder is fabricated using 600 mm × 40 mm plate as top flange, 1200 mm × 8 mm plate as web and 460 mm × 40 mm plate as bottom flange. Two 190 mm × 40 mm plates are attached to the top flange as stiffeners. The crane girder has two wheels on the gantry girder. Load on each wheel of the crane girder is 420 kN. Assume selfweight of the gantry girder as 4.67 kN/m and spacing of truss column as 5 m. Check safety of the gantry girder against shear force caused by vertical loads only. Perform necessary bearing and intermediate stiffeners design also. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2, E = 2 × 10^5 N/mm^2.

12

9. A gantry column, 13 m long, is fixed at base and hinged at top. The length of the crane leg is 10 m and that for roof leg is 3 m. The axial compression on roof leg is 50 kN and that on crane leg is 900 kN. The crane leg is fabricated using 2-ISMB 500 @ 86.9 kg/m spaced 1m apart from each other and the roof leg uses ISMB 500. Check the safety of the gantry column against the axial compression only. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2, E = 2 × 10^5 N/mm^2, sectional area (A) of each I – section = 110.74 cm^2, I_{xx} = 45218.3 cm^4, I_{yy} = 1369.7 cm^4, width of flange (b_f) = 180 mm, thickness of flange (t_f) = 17.2 mm, thickness of web (t_w) = 10.2 mm.

12

DESIGN OF STEEL STRUCTURES
(CIVL 3201)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

N.B.: BOOKLET CONTAINING NECESSARY DATA, TABLES & FIGS. WILL BE PROVIDED WHICH IS TO BE RETURNED WITH ANSWER SCRIPT

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i) As per IS: 800–2007, the partial factor of safety for material resistance governed by yielding (γ_{m0}) is,
   (a) 1.20 (b) 1.10 (c) 1.30 (d) 1.40.

   (ii) Which of the followings are the Yield and Ultimate stresses of a bolt of Grade 5.6?
   (a) 180 MPa and 330 MPa (b) 300 MPa and 500 MPa
   (c) 240 MPa and 400 MPa (d) 400 MPa and 520 MPa.

   (iii) What is the minimum pitch for a bolt of nominal diameter 20 mm?
   (a) 40 mm (b) 50 mm (c) 80 mm (d) 30 mm.

   (iv) What is the minimum 'End Returns' in case of fillet weld of size 's'?
   (a) s (b) 2s (c) 3s (d) 4s.

   (v) In order to maintain the 'Serviceability Requirement' of beams and plate girders free from transverse stiffeners, what is the value of overall depth of girder to web thickness ratio (d/t_w ratio)?
   (a) 100ε (b) 200ε (c) 70ε (d) 270ε.

   (vi) What is the maximum effective slenderness ratio for a member carrying compressive loads resulting from dead loads and imposed loads?
   (a) 250 (b) 180 (c) 300 (d) 400.

   (vii) What is the nominal bearing strength of bolt on any plate?
   (a) $2.5k_b dt_u/\gamma_{m0}$ (b) $2.5k_b dtf_u$
   (c) $2.5k_b dt_y/\gamma_{m0}$ (d) $2.5k_b dtf_u/\gamma_{mb}$